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CURIOUS OPEN WATER FEATURE IN THE ICE AT THE HEAD OF CAMBRIDGE FIORD

MOIRA DUNBAR (*)

ABSTRACT

In April 1951 the RCAF photographed a pool in the fast ice of Cambridge Fiord which formed such a perfect circle, and had such clean edges, that it was at first mistaken for a spot on the negative. The area was photographed at intervals for the next two years, and each year the pool reappeared in an otherwise continuous cover of fast ice. It varied from about 150 to 300 feet in diameter and appeared, in one year at last, quite late in the season, a photograph in February showing no sign of it. An attempt will be made to analyse the evidence in the photographs, to correlate it with the available meteorological and hydrological data, and to suggest possible causes for the phenomenon.

On 30 April 1951 an R.C.A.F. aircraft on a training flight photographed an open pool at the head of Cambridge Fiord in northeast Baffin Island. This pool or hole in the otherwise complete fast ice cover of the fiord was so perfectly circular that it was taken for a blot on the negative until members of the crew insisted that they had seen it with their own eyes. (Fig. 1) It was about 312 feet across and close to shore at a place where the coast made almost a right angle, the centre of the pool being 600 feet from the shore on each side of the angle.

In the two following years it was possible to get further photographs of the area during the late winter. In 1952 it was photographed six times between March 5 and May 29, and in 1953 three times between the middle of February and the end of April. In each year the pool reappeared in exactly the same place. It was always circular, though never quite so geometrically perfect as in the first photograph, but its diameter varied somewhat from year to year. Thus on 30 April 1951 it was about 312 feet, on the same date in 1952 about 208 feet, and on 29 April 1953 only 156 feet. In 1952, the only year in which it was possible to trace its development, it grew from 112 feet on March 5 to 229 feet on May 29, and a narrow crack gradually spread shorewards from it. (Fig. 2) This crack was about 200 feet long on April 2 and had connected with the shore by April 17, with a small opening running southeastwards from it along the shoreline. A very interesting point was noted in 1953, when photographs taken on February 17 and March 15 revealed an unbroken ice-cover with no sign of a pool, which however appeared between then and April 29, the date of the next observation. Thus it apparently does not remain open all through the winter, but opens up late in the season, the date varying in the years of observation from before March 5 (the earliest date it has been seen) to later than March 15.

In 1957, after an interval of three years, the pool was again photographed. On May 20 it was about 218 feet across, with a crack joining it to the shore as in 1952, but running to the western instead of the southern shore. (Fig. 3) As in 1952 there was also a narrow crack at the shoreline. In at least one of the three intervening years, 1954-6, the pool was observed visually though not photographed. There is therefore little doubt it is a regular annual phenomenon.

The question of what causes this opening in the ice is an intriguing one to which there seems to be no easy or obvious solution. In the absence of any field observations it is not possible to attempt to find an answer, merely to present the problem and

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suggest a few possible lines of approach. Open patches as such are not uncommon; they occur for instance in Frobisher Bay and Cumberland Sound, where they are apparently due to water turbulence, and in many other parts of the Arctic where strong currents keep ice from forming. There is no other known case in the Canadian Arctic, however, of an open pool at the head of a long narrow fiord; in the many such fiords in eastern Baffin Island, Ellesmere Island, and Axel Heiberg Island the ice cover is normally complete and often very smooth, suggesting that it forms in

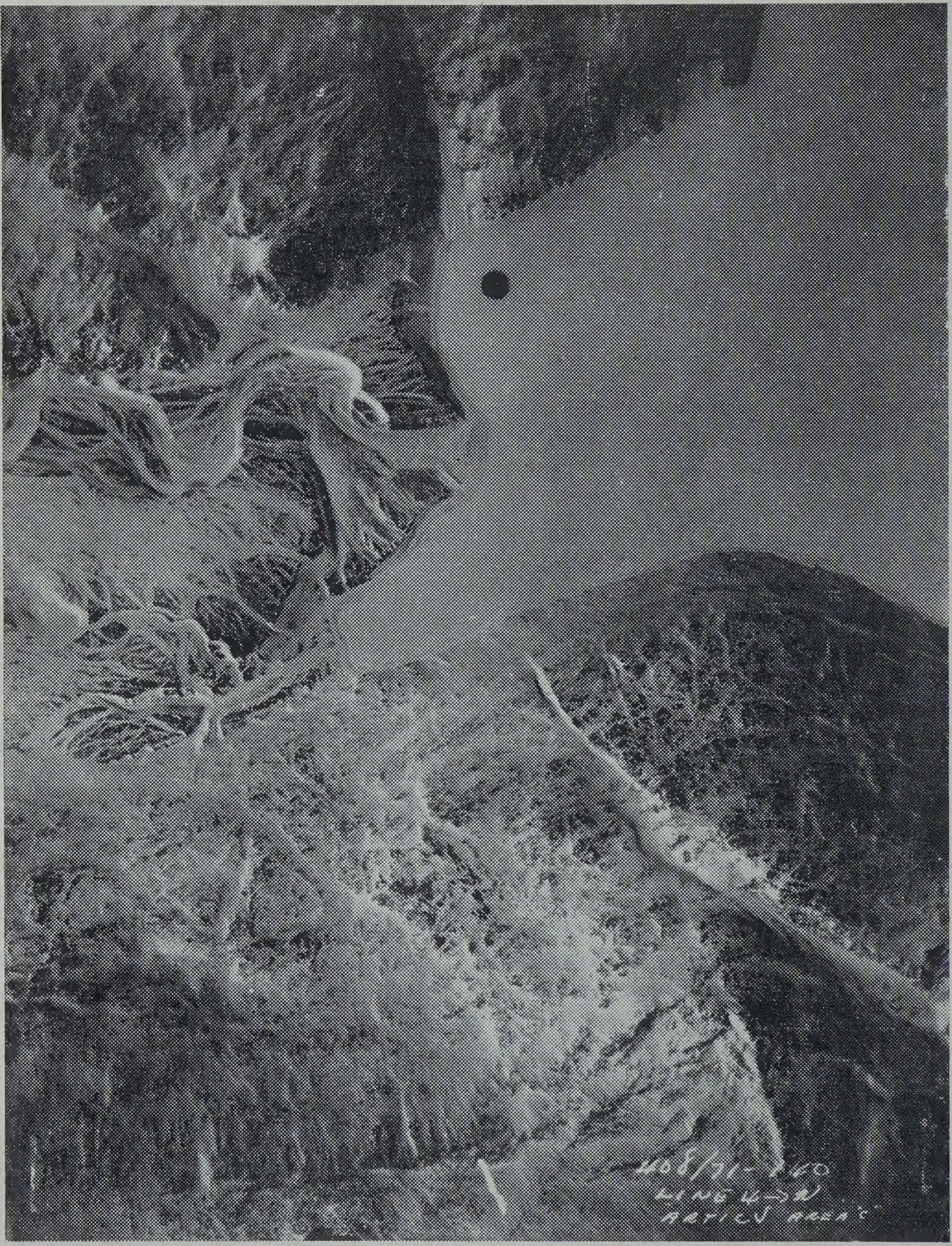

Fig. 1 — The pool as first photographed, 30 April 1951. Vertical photograph taken from 10.000 feet.

quiet water. Furthermore, in places where open pools occur, there are normally several rather than just one, and they are usually larger and quite irregular in outline.

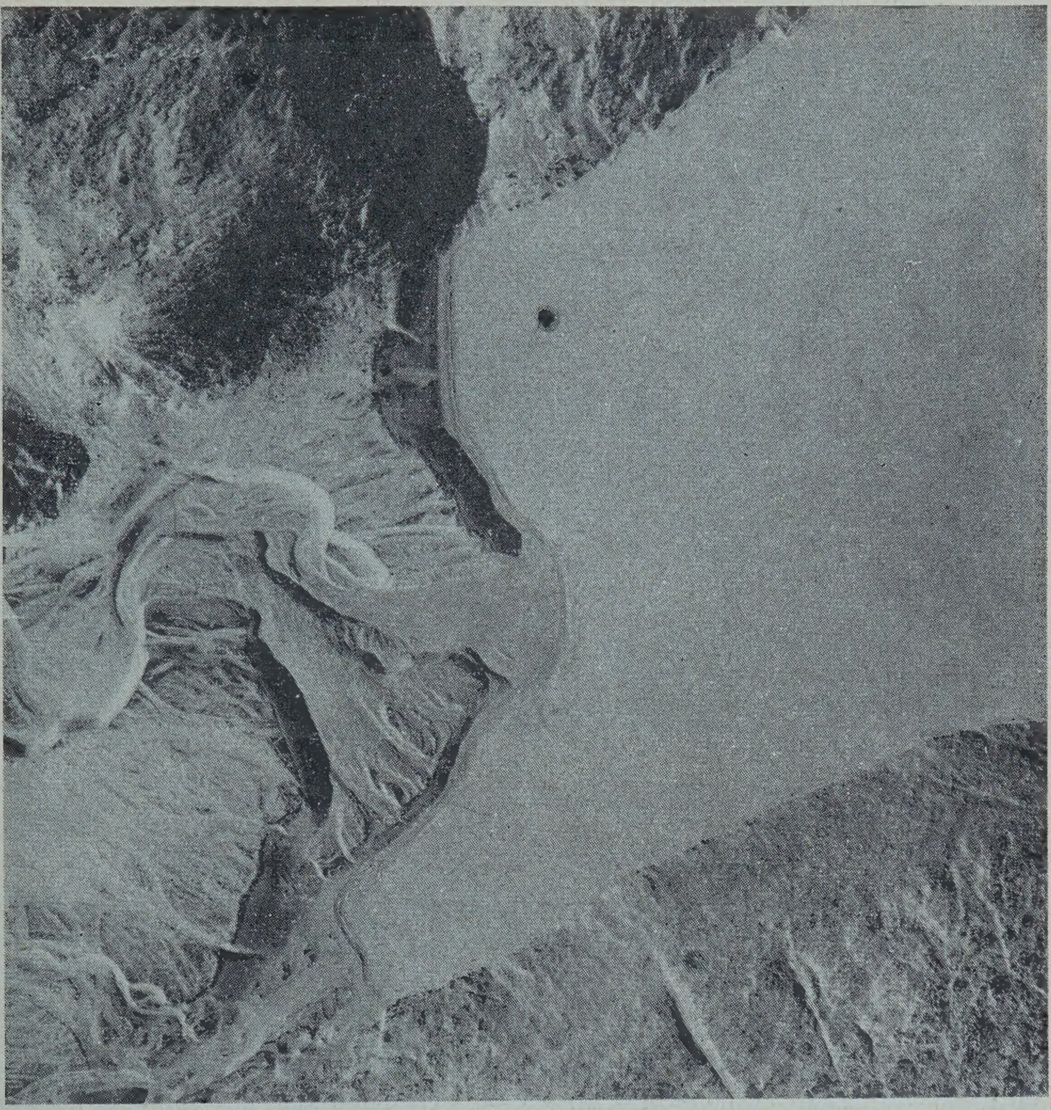

Fig. 2 — 2 April 1952, taken from 6.000 feet. Note the creek beginning to form which later extended to the shoreline.

Another quite abnormal feature of this pool is its appearance late in the season. Pools caused by tidal currents or other forms of water turbulence owe their existence to the fact that either mixing or sheer speed of water movement prevents ice from forming; thus they remain open from the time of freeze-up, and if they freeze over at all it is late in the winter, when accumulation of frost has chilled all the available water to freezing point.

For these reasons it seems unlikely that the feature is a purely oceanographic one. Its proximity to shore, too, leads one to surmise that it may be more closely connected with the physiography and hydrology of the area. Let us therefore consider what little information is available on this subject.

The area is part of the uplifted eastern edge of the Canadian Shield, and appears to be entirely Precambrian, consisting of gneissic rocks. (Fig. 4) The fiord is one of the longest of eastern Baffin Island and penetrates through the mountainous coastal belt, which rises in this area to about 5000-6000 feet, to the plateau of central Baffin Island, about 2000 feet. Minor faults are common and the uplift of the area has left a series of terraces so well developed that J.M. Wordie, who visited the fiord by ship in 1937, originally called it Glen Roy Fiord, after Glen Roy in Scotland, the classic example of terrace development. The highest terraces observed by Wordie he judged to be at about 1500 feet, and he considered these to have been formed in an ice-dammed lake. No geological results of this expedition were published, and the only man to visit this area since then was G.W. Rowley, who made a winter journey across Baffin Island by way of the Rowley River in 1939, emerging into Keel Bay. He did not unfortunately pass close to the site of the pool and made no geological observations.

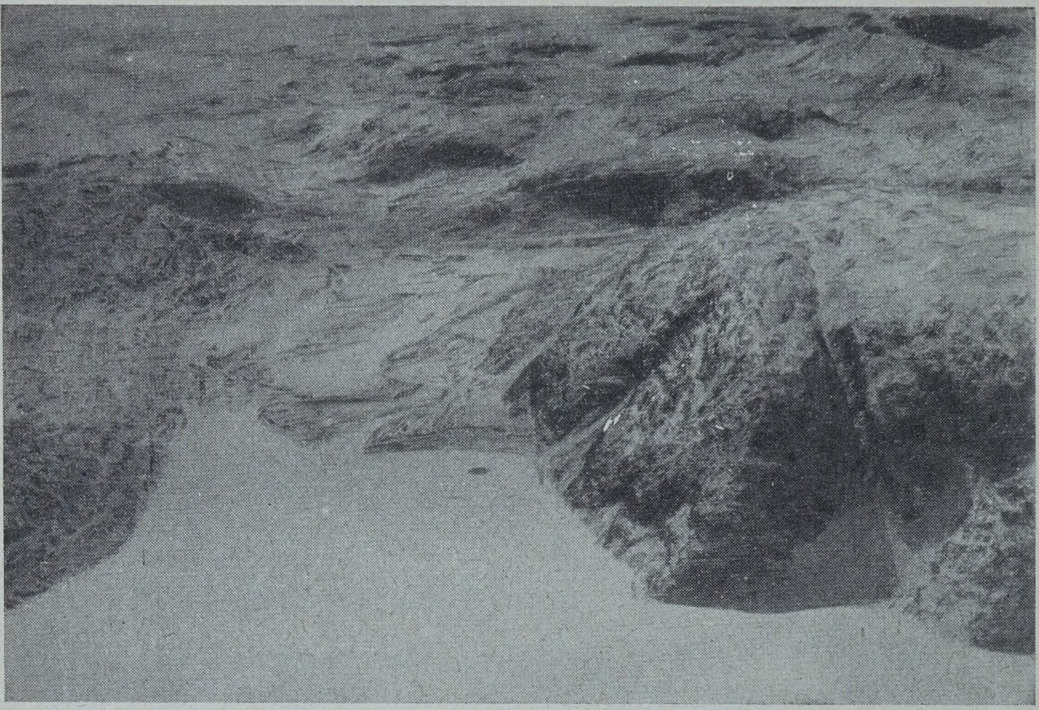

Fig. 3 — Oblique view looking southwest. 20 May 1957, altitude 5.970 feet.

Climatically the area is presumably influenced by the proximity of Baffin Bay, but the maritime effect will be modified by its distance from the coast and the mountains which intervene. Of the meteorological stations available, Clyde and Arctic Bay, neither is strictly comparable; the climate is likely to be somewhat between the two, with mean winter temperatures of about —15 to —25°F and summer temperatures about 40-45°F; annual precipitation about 6 inches; and mean cloudiness about 60%. In late winter the weather, as in most of the Canadian Arctic, should be mainly cold and clear. A comparison of meteorological records for Arctic Bay and Clyde for the years in question shows no apparent correlation with the dates of appearance or size of the pool.

The theoretical period of continuous sunshine is from May 12 to August 8, and the sun is continuously below the horizon from November 21 to January 23.

The mountainous terrain will greatly modify these dates however; the spring reappearance of the sun, for instance, will be retarded several days. The pool thus makes its appearance about 4 to 6 weeks after the sun rises above the horizon, but it is hard to see any connection here either. It is much too early in the season for surface melting, and no signs of any appear in any of the photographs. The ice at this period is indeed still growing and has not reached its maximum thickness. Ice measurements made by Bernier at Pond Inlet in 1906-7 and at Arctic Bay in 1910-11 show a maximum thickness of 56-61 inches and a decrease beginning about the end of May or beginning of June, and it is likely that conditions in Cambridge Fiord are somewhat similar.

It would appear that the explanation must involve the existence for one reason or another of a narrow column of water welling up under the ice. This could, of course, be a purely oceanographic phenomenon; nothing is known of the depth of water or other oceanographic factors. For reasons already stated, however, a land-water origin seems more probable. The possibilities seem to be:

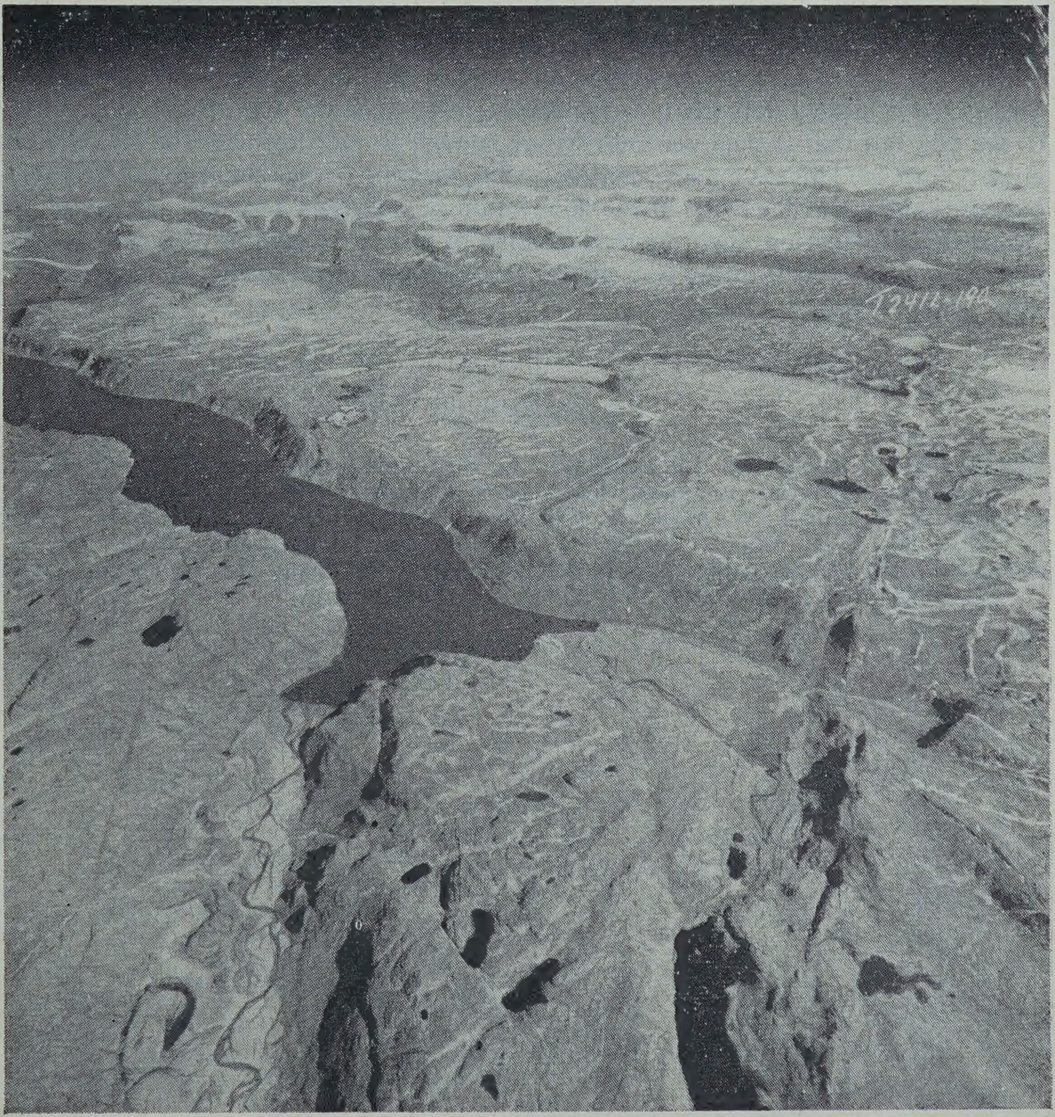

Fig. 4 — Cambridge Fiord looking east, showing the general terrain. Keel Bay is the left bay of the three indentations at the head of the fiord, and the site of the pool is in the centre one. Altitude 20.000 feet.

(1) Surface or sub-surface run-off under the ice

(2) Underground water.

The main drainage into the fiord is by the river flowing into Keel Bay; the stream that enters the fiord near the pool is a short one originating in a lake only about five miles inland. There is no sign of open reaches in any of the winter photographs of this stream, and the wide mouth of the stream freezes over very smoothly, with the surface generally swept clear of snow; but photographs taken in September show what appears to be a fair flow of water about 30 feet wide, and it may well be that the flow continues all winter under the ice. The hole is not, however, opposite the mouth of the river but very much to one side, and there is no obvious reason to connect the two. Furthermore surface run-off would be unlikely to result in a perfectly round pool.

There remains underground water in the form of springs, either hot or cold. The area is one of hard impervious rock, but the many faults suggest that springs from below the permafrost are by no means improbable. And a spring could provide the kind of narrow, even column of water necessary to produce such a pool. The late winter opening however remains puzzling. It might be expected that any spring, hot or cold, would keep the pool open all through the winter. The late opening presupposes not merely that the flow is insufficient to keep the area from freezing over in the fall, but that it then becomes strong enough to melt through the ice that has already formed. This ice may be relatively thin, forming a weak point in the ice cover, but some change in the force of the flow would be necessary to cause it to open up. A possible explanation might be that freezing of the active layer at this time of year reaches a stage that in some way affects the hydrostatic pressure and increases the flow of the spring.

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